NOTES ON SOME EFFECTS OF PARASITISM UPON A SMALL POPULATION OF DIADASIA BITUBERCULATA (CRESSON)

(Hymenoptera: Anthophoridae)

E. G. LINSLEY AND J. W. MACSWAIN
University of California, Berkeley

On several occasions, in the course of studies of the biology of bees, the writers have found abandoned nesting sites of gregarious ground-nesting species. In some cases the disappearance of the bees could be attributed to an extended period of drought or some other physical factor in the environment. However, a few cases did not appear explicable on any such basis and, since abundant evidence was present that there had been a high incidence of parasites and predators in the population, it was suspected that biotic factors might have played an important role in the disappearance of the bees. It may therefore be of interest to report observations on the effects of parasitism on a population of *Diadasia bituberculata* (Cresson), in which the net result was to reduce the population to such a low level as to virtually exterminate it.

Diadasia biturberculata is a gregarious, ground-nesting anthophorid, which collects pollen from *Convolvulus arvensis* Linnaeus. Its nesting habits are similar to those of *D. consociata* Timberlake which will be described elsewhere (Linsley, MacSwain & Smith, 1952a) although the pupal period is apparently shorter (23 - 25 days). The nesting site involved in the following observations extended for about 50 feet along a hard-packed, rarely used dirt road near Barrett Springs, San Diego County, California. When the site was discovered on April 20, 1950, there were indications that large numbers of cells had been provisioned during the previous season although but two male bees were in evidence about the area. A sample of 337 cells was removed at this time. These were examined on April 25 with the results indicated in Table I. When the site was revisited in July 1950, no adult bees were evident and sampling failed to yield any living bee larvae or cell series which had been provisioned during the 1950 season.

Molds, as is often the case with ground nesting bees, took a large toll in bee cells. In the sample examined 34 per cent of the cells contained mold which had apparently destroyed the cell con-

tents. *Aspergillus flavus* Link[1] was the prevalent species, although several species of *Rhizopus*[1] were also present. These last may have been secondary invaders and may be saprophytic.

Villa (Paravilla) tricellula Cole[2] was by far the most important insect parasite encountered in the nest area. Twenty-seven per cent of the cells examined contained larvae or pupae of this species. When allowance is made for the bombyliid larvae destroyed directly or indirectly by mold, it is obvious that the number of cells originally infested was much higher. Actually, *Villa* succeeded in destroying 41 per cent of those bee larvae in our sample which were not destroyed by mold. Undoubtedly many of these larvae had also been attacked by *Rhipiphorus* or *Photopsis*, both of which would also be destroyed by *Villa*.

Rhipiphorus diadasiae Linsley and MacSwain destroyed bee larvae in 18.5 per cent of the non-moldy cells examined, although this figure would be higher if bee larvae containing this parasite which were destroyed by *Villa*, *Photopsis* or *Lytta* could be determined. From these figures involved it is estimated that approximately thirty per cent of all cells were originally infested with Rhipiphorid larvae. The feeding habits of this species are like those to be reported in detail elsewhere for *Rhipiphorus smithi* Linsley and MacSwain, (LINSLEY, MACSWAIN AND SMITH, 1952b). The external feeding period, period between completion of feeding and pupation, as well as the pupal period were obtained for 10 specimens of *R. diadasiae*. These periods in sequence averaged 6.3 days (range 6-8); 4.9 days (range 3-7); and 12.9 days (range 11-15). The fragmentary biological observations on this species differ markedly from the more complete study of *R. smithi* in one important detail. In *R. smithi* over 99 per cent of the adult beetles escaped from the soil whereas a high percentage of *R. diadasiae* failed to reach the surface. However, this latter circumstance might well have been due to some purely local condition where the study was made.

Photopsis auraria Blake[3] has been reported previously as a parasite of *Anthophora linsleyi* Timberlake (Linsley and McSwain, 1942). As far as could be determined its habits as a parasite of

---

[1]Identified by E. A. Steinhaus, Division of Biological Control, University of California, Berkeley, California.

[2]Identified by F. R. Cole, Redlands, California.

[3]Identified by C. E. Mickel.

Table I. — Parasites and predators in a nest sample of *Diadasia bituberculata* (Cresson) examined April 25, 1950[1].

Material examined and stages present	Number of cells	Per cent of total	Per cent of non-moldy cells (248)
Cells sampled	377	100.0	100.0
Unparasitized *Diadasia bituberculata*			
overwintering larvae	32	12.5	
adults	15		21.8
Bees (adults) dead from unknown causes	7	1.9	
Cell contents destroyed by molds	129	34.2	
Villa (Paravilla) tricellula (Bombyliidae)			
larvae	84		
pupae (including 7 dead)	18	27.1	41.1
Rhipiphorus diadasiae (Rhipiphoridae)			
larvae (endoparasitic first instar)	12		
pupae	2	12.1	18.5
adults (including 26 dead)	32		
Photopsis auraria (Mutillidae)			
larvae	5		
pupae	8	5.3	8.1
adults (including 3 dead)	7		
Photopsis sp. (Mutillidae)			
larvae	11	2.9	4.4
Lytta melaena (Meloidae)			
larvae	11	4.0	6.1
pupae	4		

[1]All identifications based upon reared adults.

D. bituberculata are as described for *Anthophora*. Seven females and six males were ultimately reared. The females were identified by C. E. Mickel as *P. auraria* Blake, 1879 and the males as *P. nebulosa* Blake, 1886. On the basis of habits, cocoon structure, and coincidence of emergence we regard them as a single species, *Photopsis auraria* Blake, a conclusion also suggested by Dr. Mickel *(in*

litt.). Emergence dates for the females ranged from April 20 to May 23, the males, with one exception, from April 28 to May 18. One male, however, did not pupate until May 18 and did not transform until June 19. 5.3 per cent of the cells examined contained *P. auraria*, which had parasitized 8.1 per cent of the bee larvae not killed by mold, *Villa* or *Lytta*.

Photopsis sp., represented by 11 larvae from which six females were ultimately reared, is smaller than *P. auraria*, the larvae construct a more delicate cocoon, and adults did not emerge until July. Whether these specimens were retarded in development by our methods of laboratory rearing or whether they actually represent a different species remains to be determined. This form was found in 2.9 per cent of the cells examined and had destroyed 4.4 per cent of the bee larvae which were not destroyed by mold, bombyliids or meloids.

Lytta melaena (LeConte) may have had a greater effect on the host bee than that indicated in Table I. The fifteen larvae and pupae were found in resting cells removed from the series upon which the earlier larval stages had fed. Since larvae of several species of this genus have been found destroying one or more cells, depending upon the size of the host attacked, it is possible that the larvae of this species may have destroyed two cells each in completing their development. This is a rather large black species whose mature larvae are somewhat larger than the *Diadasia* larva. The authors have observed oviposition in more than twenty species of *Lytta*, including close relatives of *L. melaena*. For this reason it is probably safe to assume that *melaena* follows the normal pattern of preparing a short burrow in the soil to a depth of two to three inches and laying several hundred eggs at the end of the burrow. The incubation period for the eggs of other members of the genus is about two weeks, after which the first instar larvae crawl over the surface searching out new cell series of their host. Although the authors previously (1942) presumed that larvae of *L. occipitalis* Horn contacted the host bees by climbing surrounding vegetation, they now appreciate that this assumption was erroneous. The feeding habit of this genus is apparently that of a specialized predator which consumes the contents of one or more cells regardless of their nature. After the first four feeding instars the larva burrows several inches away from the cell series and constructs a resting chamber. This activity appears to effectively protect the

meloid from parasitism by other members of the community. Of the 15 specimens collected only the four listed as pupae in Table I transformed during the season in which they were collected. The 11 larvae have not yet transformed as of June, 1952. We have previously observed this habit in meloids which attack bees and apparently it is a mechanism to carry the species over unfavorable seasons.

LITERATURE CITED

LINSLEY, E. G. AND J. W. MACSWAIN

1942. The parasites, predators, and inquiline associates of Anthophora linsleyi. Amer. Midland Naturalist, 27:402-417, figs. 1-11.

1945. Longevity of fifth instar larvae of Hornia boharti Linsley. Pan-Pac. Ent., 21:88.

1950. New western species of Rhipiphoridae. Wasmann Jour. Biol., 8:229-239.

LINSLEY, E. G., J. W. MACSWAIN AND R. F. SMITH

1952a. The bionomics of Diadasia consociata Timberlake and some biological relationships of emphorine and anthophorine bees. Univ. Calif. Publ. Entom. (in press).

1952b. The life history of Rhipiphorus smithi with notes on their phylogenetic significance. Univ. Calif. Publ. Entom. (in press).

THE HABITAT OF TWO RARE CALIFORNIAN HISTERIDAE

(Coleoptera)

Onthophilus lecontei Horn, 1870, and *Margarinotus remotus* (Leconte), 1859, are among the rarest of Californian Histeridae. As is often the case in rare insects, the rarity is due apparently to the restriction of these species to a special ecological niche seldom investigated by collectors. Dr. F. X. Williams has recently presented the California Academy of Sciences with a series of 14 specimens of *O. lecontei* and 13 of *M. remotus* collected in company with numerous individuals of the common *Saprinus paeminosus* Leconte in the nest chamber and burrows of *Thomomys bottae bottae* Eydoux & Gervais (Botta pocket gopher) at Danville, Contra Costa Co., Calif., February 9, through April 17, 1952.

This is strong evidence that such burrows constitute the normal habitat of these two species. With one exception (a specimen of *lecontei* collected in a gopher burrow at Atascadero, Calif.) all other known specimens have been collected as stragglers during the rare periods when the species ranged out of their normal habitat.—EDWARD S. ROSS, *California Academy of Sciences.*